CLAIMS

What is Claimed is:

1. A film surface imprinted with nanometer-sized particles to produce micro- and/or nano-structured electron and hole collecting interfaces, comprising;

at least one transparent substrate;

at least one photoabsorbing conjugated polymer applied on a first said substrate, wherein said conjugate polymer includes polybutylthiophene (pbT);

a sufficient amount of nanometer-sized particles including multiwalled carbon nanotubes (MWNT) to produce a charge separation interface;

at least one transparent polymerizable layer including a sol-gel or monomer,

said MWNT embedded in said conjugated polymer to produce a mixture and applied on a second said substrate to form a MWNT bearing surface film layer to form a stamp surface;

wherein said stamp surface is imprinted into the surface of said polymerizable film layer to produce micro- and/or nano-structured electron and hole collecting interfaces;

polymerizing said polymerizable film layer to promote shrinkage to form a conformal gap between said MWNT stamp surface and said surface of said polymerizable film layer; and

filling said gap with at least one photoabsorbing material to promote the generation of photoexcited electrons and transport to the charge separation interface.

2. The film according to claim 1, wherein either said polymerizable layer and said conjugated polymer is applied by processes comprising at least one of spin-coating, dip-coating, spray-coating, flow-coating, doctor blade coating, and screen-printing.

3. The film according to claim 1, wherein said nanometer-sized particles having average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1 nm to about 1 cm in length.

4. The film according to claim 3, wherein said nanometer-sized particles having average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1 nm to about 500 nm in length.

5. The film according to claim 1, wherein said nanometer-sized particles further comprises at least one of SWNT, and nanocrystals of semiconductor materials.

6. The film according to claim 5, wherein said nanocrystals of semiconductor materials comprises at least one of CdSe, metal nanowires, and metal-filled carbon nanotubes.

7. The film according to claim 1, wherein applying said polymerizable film layer ranging in thickness from about 1 nm to about 1 mm.

8. The film according to claim 1, wherein applying said conjugated polymer mixture ranging in thickness from up to about 100 nm.

9. The film according to claim 1, wherein said polymerizable layer comprises at least one monomer film.

10. The film according to claim 1, wherein said polymerizable layer comprises at least one sol-gel film.

11. The film according to claim 1, wherein said sol-gel includes absolute alcohol and ultrapure water in a ratio of about (1:0.025) and said metal oxide includes titanium oxide and/or zinc oxide.

12. The film according to claim 1, wherein said monomer comprising at least one of oxadiazole, aniline, and pyrrole.

13. The film according to claim 1, wherein said photoabsorbing material comprises at least one of thermotropic liquid crystalline materials, polybutylthiophene (pbT)/chlorobenzene, and polyelectrolytes.

14. A film surface imprinted with nanometer-sized particles prepared by a process to produce micro- and/or nano-structured electron and hole collecting interfaces, comprising:

providing at least one transparent substrate;

providing at least one photoabsorbing conjugated polymer;

providing a sufficient amount of nanometer-sized particles to produce a charge separation interface;

providing at least one transparent polymerizable layer including a sol-gel or monomer;

embedding said nanometer-sized particles in said conjugated polymer;

applying said polymerizable layer on a first said substrate to form a charge transport film layer;

applying said conjugated polymer/nanometer-sized particle mixture on a second said substrate to form a nanometer-sized particles bearing surface film layer, wherein said nanometer-sized particles form a stamp surface;

imprinting said stamp surface into the surface of said polymerizable film layer to produce micro- and/or nano-structured electron and hole collecting interfaces;

polymerizing said polymerizable film layer to promote shrinkage to form a conformal gap between said stamp surface and said surface of said polymerizable film layer; and

filling said gap with at least one photoabsorbing material to promote the generation of photoexcited electrons and transport to the charge separation interface.

15. The film according to claim 14, wherein said imprinting includes compressing and thereafter, solidifying said stamp surface into said surface of said polymerizable layer.

16. The film according to claim 14, wherein said nanometer-sized particles having average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1 nm to about 1 cm in length.

17. The film according to claim 16, wherein said nanometer-sized particles having average particle sizes of about 1 nm to about 100 nm in diameter and up to about 1 nm to about 500 nm in length.

18. The film according to claim 14, wherein said nanometer-sized particles further comprises at least one of SWNT, and nanocrystals of semiconductor materials.

19. The film according to claim 18, wherein said nanocrystals of semiconductor materials comprises at least one of CdSe, metal nanowires, and metal-filled carbon nanotubes.

20. The film according to claim 14, wherein applying said polymerizable film layer ranging in thickness from about 1 nm to about 1 mm.

21. The film according to claim 14, wherein applying said conjugated polymer mixture ranging in thickness from up to about 100 nm.

22. The film according to claim 14, further comprising electrophoretically depositing said nanometer-sized particles onto said polymerizable layer.

23. The film according to claim 22, wherein said nanometer-sized particles include TiOx nanometer-sized particles.

24. The film according to claim 14, wherein said sol-gel includes absolute alcohol and ultrapure water in a ratio of about (1:0.025) and a metal oxide.

25. The film according to claim 24, wherein said metal oxide comprises at least one of inorganic metal salts and metal organic compounds.

26. The film according to claim 25, wherein said metal organic compounds include metal alkoxides comprising at least one of titanium isopropoxide and zinc butoxide.

27. The film according to claim 14, wherein said monomer comprising at least one of oxadiazole, aniline, and pyrrole.

28. The film according to claim 14, wherein said substrate acts as an electrode by comprising a coating of at least one transparent metal oxide including SnO_2:F, SnO_2:In (ITO), and Au.

29. The film according to claim 14, wherein said substrate acts as an electrode by comprising a coating of at least one transparent metal oxide being conducting polymers including polythiophenes, polypyrroles, polyanilines, and polybutylthiophenes.

30. The film according to claim 14, wherein said conjugated polymer includes pbT dissolved in chlorobenzene.

31. The film according to claim 14, wherein said photoabsorbing material comprises at least one of thermotropic liquid crystalline materials, polybutylthiophene (pbT)/chlorobenzene, and polyelectrolytes.

32. The film according to claim 14, wherein said substrate comprises at least one of silicon, silicate, plastic, and plastic-like materials.

33. The films surface imprinted with nanometer-sized particles are obtained by the process defined in claim 14.

34. The film according to claim 1, wherein said film being utilized in a photovoltaic device or other light guiding device.

35. A film surface imprinted with nanometer-sized particles to produce micro- and/or nano-structured electron and hole collecting interfaces, comprising;

at least one transparent substrate;

at least one photoabsorbing conjugated polymer applied on a first said substrate, wherein said conjugate polymer includes polybutylthiophene (pbT);

a sufficient amount of nanometer-sized particles including multiwalled carbon nanotubes (MWNT) to produce a charge separation interface;

at least one transparent polymerizable layer including polymer,

said MWNT embedded in said conjugated polymer to produce a mixture and applied on a second said substrate to form a MWNT bearing surface film layer to form a stamp surface;

wherein said stamp surface is imprinted into the surface of said polymerizable film layer to produce micro- and/or nano-structured electron and hole collecting interfaces;

polymerizing said polymerizable film layer to promote shrinkage to form a conformal gap between said MWNT stamp surface and said surface of said polymerizable film layer; and

filling said gap with at least one photoabsorbing material to promote the generation of photoexcited electrons and transport to the charge separation interface.

36. The film according to claim 35, wherein said polymer comprising at least one of nitrogen containing heterocycle(s) and polyaniline.